Zeigler (1)

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Reference No. 58-26

BEACH STUDIES IN THE CAPE COD AREA

conducted during the period

January 1, 1958 - June 1, 1958

WOODS HOLE, MASSACHUSETTS

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Periodic Status Report
Submitted to Geography Branch, Office of Naval Research
Under Contract Nonr-1254(00)(NR-388-018)

May 1958

APPROVED FOR DISTRIBUTION C.O'D. Iselin

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* Mr. Geise returned from leave of absence and is replacing Mrs. Gill.

The program of measuring beaches every working day, as reported in Reference No. 57-34, has been continued during the past six months. Four lines have been maintained on Outer Cape Cod beaches, at High Head, Highland, Race Point and New Beach (Figure 1). A line was installed at Sandy Neck beach in Barnstable and maintained until the severe northeast storms of March and April washed out the pipes used for measuring elevation of the sand. Since the summer season was soon to begin and the pipes would present a hazard to beach traffic and swimmers the line was not re-established. However, the line is surveyed periodically to show the recovery of the beach from the storm profile.

Measurements of surf conditions have been made concurrently with the beach measurements at low tide, and are now also being made at high tide, thus giving a more comprehensive view of the relationship of these parameters to the change in beach characteristics during a tidal cycle.

Early in February an anemometer was installed at Provincetown, allowing more reliable records of the wind velocity. Previously, estimated Beaufort readings from the Coast Guard Station at Race Point were the only data available.

The data obtained are being processed to reveal correlations between various properties of the beach and the sea state. Parameters now being analyzed include: wave angle, surf height, surf period, wind velocity and direction, total beach volume, volume of backshore and foreshore, and slope. Variation in tidal cycle and the "reach" of the tide on the beach are now being incorporated into the analysis of the data obtained.

Correlation diagrams of these parameters are being plotted for each of the four lines in an attempt to derive equations describing the beach processes involved. Figure 2 is an example of such a correlation diagram showing the relationship of cut and fill to the total volume of the beach on the New Beach line.

Equations for straight lines fitted to these points would have the following form:

$$V = \frac{V_2 - V_1}{C_2 - C_1} (C - C_1) \qquad \text{for cut}$$

and

$$V = \frac{V_2 - V_1}{F_2 - F_1} (F - F_1)$$ for fill

where V = total volume of the beach

C = cut

F = fill

The problem of obtaining more accurate measurements of sea state characteristics remains. In the direction of solving this problem, a new approach to the measurement of wave characteristics will be used this summer. Through the use of time-lapse photography and a Canadian grid it is hoped that a method for obtaining wave length and height can be developed which will be superior to the present visual estimations used.

During the winter months we were fortunate in observing the effects of a series of northeast storms which hit the Outer Cape Cod beaches. During December 1957 the tip of the south spit at Nauset Inlet was broken off, and the action of the winter storms has reduced the length of the spit from approximately 4,050 feet on October 21, 1957 to 1,850 feet on April 10, 1958. A tabulation of the lengths of the spit measured from aerial photographs follows.

Date	Length of Spit in feet
October 21, 1957	4,050
December 19, 1957	2,846*
March 13 1958	1,960
April 5, 1958	1,940
April 10, 1958	1,850

* The length of the spit from the tip of the broken segment to the south end of the spit was 4,480, including the breakthrough area.

The last and most violent of the winter storms came when the beach had been wasted by previous northeasters. During this storm the base of the cliff was cut from Highland south to Nauset, with extensive damage in many

areas. The dunes on the north spit at Nauset were cut back severely and a new breakthrough formed. The lines at Nauset that had been discontinued since 1956 were re-established and surveyed to give an indication of dune retreat and volume loss during the period of the study. The distance from the dune edge to the established control points behind the dunes are tabulated below with the volume changes approximated from these distances for a one-foot section of the dune.

Distance from control point

Line	Nov. 1954	Mar. 1956	Oct. 1956	Apr. 1958	Dune height	Loss in distance	Volume loss
Nauset "A"	267	263	261	257	10.5'	10'	105 cu. ft.
Nauset "B"	--	--	298	280	14'	18'	252 cu. ft.
Nauset "C"	--	--	234	223	12'	11'	132 cu. ft.

A further check on the erosion of the beaches during the past winter will be made by resurveying the Marindin lines run in 1956 (Ref. No. 57-62).

Five hundred and eighty-four samples taken during the summer of 1957 at Highland and Pamet River (Ref. No. 57-62) have been analyzed using the Woods Hole Rapid Sediment Analyzer and the data are ready for I.B.M. at Chicago. The method used will be the same as that reported in Ref. No. 57-62 for the Falmouth Beach Study, Miller and Zeigler (1958) Technical Report to ONR, to be circulated as soon as reprints are available, August 1958, approximately.

A sampling program is underway in the Race Point area to determine the difference in sediment pattern between a marine worked beach sediment and a wind-blown dune sediment. Plate I shows a vertical photograph of the area under consideration. The area enclosed is that to be included in the study, with the locations already sampled represented by solid circles. A 100-foot interval is used for dune sampling. Beach structure dictates more closely spaced samples. It is hoped that this sediment pattern will provide a reliable index for identifying emerged features such as spits and bars, so common on the coastal plain of the United States. One of these Pleistocene features near Tarpon Springs, Florida, was sampled by Dr. Zeigler in April. The feature is presumed to be spit which originated on the northern end of an island in the Pleistocene (MacNeil 1949, p. 103). Analysis showed the sand to be more related to wind action than sea state. We wish to determine how thoroughly wind action obliterates marine sediment pattern, hence the sampling program at Race Point.

During the past six-month period one flight for the purpose of photographing the east coast of the United States was completed. Time-lapse movies were taken of the coastline from Block Island, R.I., to Brownsville, Texas, from January 19, 1958 to January 24, 1958. The proposed flight to photograph the coastline of Cuba was cancelled.

Frequent local flights have been made to photograph the areas under study in this beach contract. Biweekly flights to photograph the beaches in the Cape Cod area have been made since March. The photo-mosaics produced form a record of the changes in the beaches and the nearshore features along Outer Cape Cod. A tabulation of the dates and coverages of the flights follows:

Date	Area Covered
March 13, 1958	Nauset; Highland to New Beach
March 18, 1958	Nauset; Highland to Race Point (high water)
March 18, 1958	Nauset; Highland to Race Point (low water)
April 4, 1958	Nauset
April 5, 1958	Nauset; Highland to Provincelands
April 10, 1958	Nauset; Highland to Provincelands
April 24, 1958	New Beach to Race Point
May 1, 1958	Nauset; Highland to Race Point
May 9, 1958	Nauset; Highland to New Beach

As can be noted from the dates of the flights, the conditions before and after the violent northeast storm of late March and early April have been recorded. Changes were noted not only in the cliff, beach, and nearshore bars, but also in the Peaked Hill Bar (offshore bar). The general statement that cuts in the beach seem to appear opposite breaks in the bar seems to hold true. The correlation between beach and bar seemed to deteriorate during the violent storms, but within a two-week period the condition described above was again evident. This aerial study should resolve at least partly the effect of nearshore topography on beach changes. In an environment which changes so rapidly the aerial camera seems to be the best charting tool.

In order to have points of reference for our photographic surveys additional Marindin lines will be run along the stretch of beach from Highland to The Provincelands.

In addition to the vertical photographs for the photo-mosaics many oblique shots were made to show the effects of the storms on the beaches and cliffs along the Outer Cape Cod beaches. Also a portion of the coast was filmed using a movie camera.

Material

Two acquisitions this past winter have greatly aided the prosecution of our beach research program: a new jeep has been provided through the good offices of ONR Boston, and a Raytheon DE-119 portable recording fathometer has been made available through purchase by the Woods Hole Oceanographic Institution.

Future Work

Some of our survey lines now being measured daily will be discontinued during the summer months and the iron pipes removed. This phase of beach sensitivity to sea state changes will be re-established in the fall. Data on hand will be processed this summer. However, two short-term (1 week) intensive surveys are planned for summer. Several lines two hundred feet apart will be established and observed every few hours for the whole period. Sea state, current measurements, and tidal cycle will be kept continuously for the duration of the field test. We are particularly concerned that sea state and current measurements in the surf zone be improved. The study areas will be chosen to exploit specific characteristics of nearshore topography and will be continued offshore to deeper water--50 to 100 feet. Bathymetric surveys will be made with a new self-recording fathometer whose resolution is excellent.

Part of the program will include observation of current patterns over the whole tidal cycle for the Outer Cape in general. Several instruments are involved, an airplane, cameras, and an airborne radiometer which will measure currents by their differences in heat, if such differences exist. Dye marker will be dropped to check the pattern.

Another area of interest is located along the shore of Cape Cod Bay from Brewster to Truro, where a large area of complex, giant ripples intersect the shore. A sampling program is planned to cover that part of this area off Eastham, particularly interesting because there is a merging of transverse ripples with ripples parallel to the shore there. The program will include a bathymetric survey and sediment sample survey. This type of nearshore giant ripple environment has been noticed in several other places along the coastal United States on coastal flights for this project.

Field parties will be active every working day on a variety of other things.

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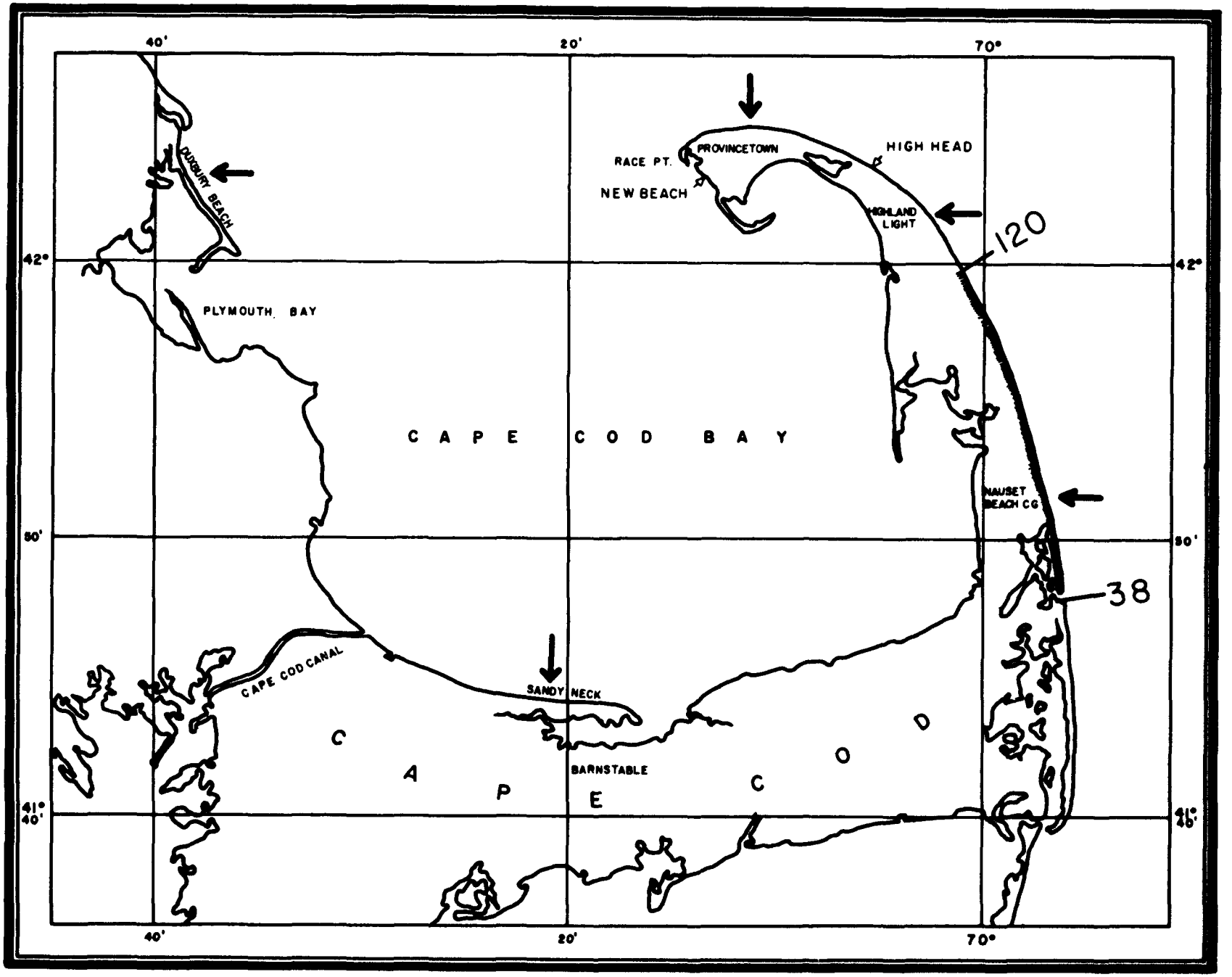
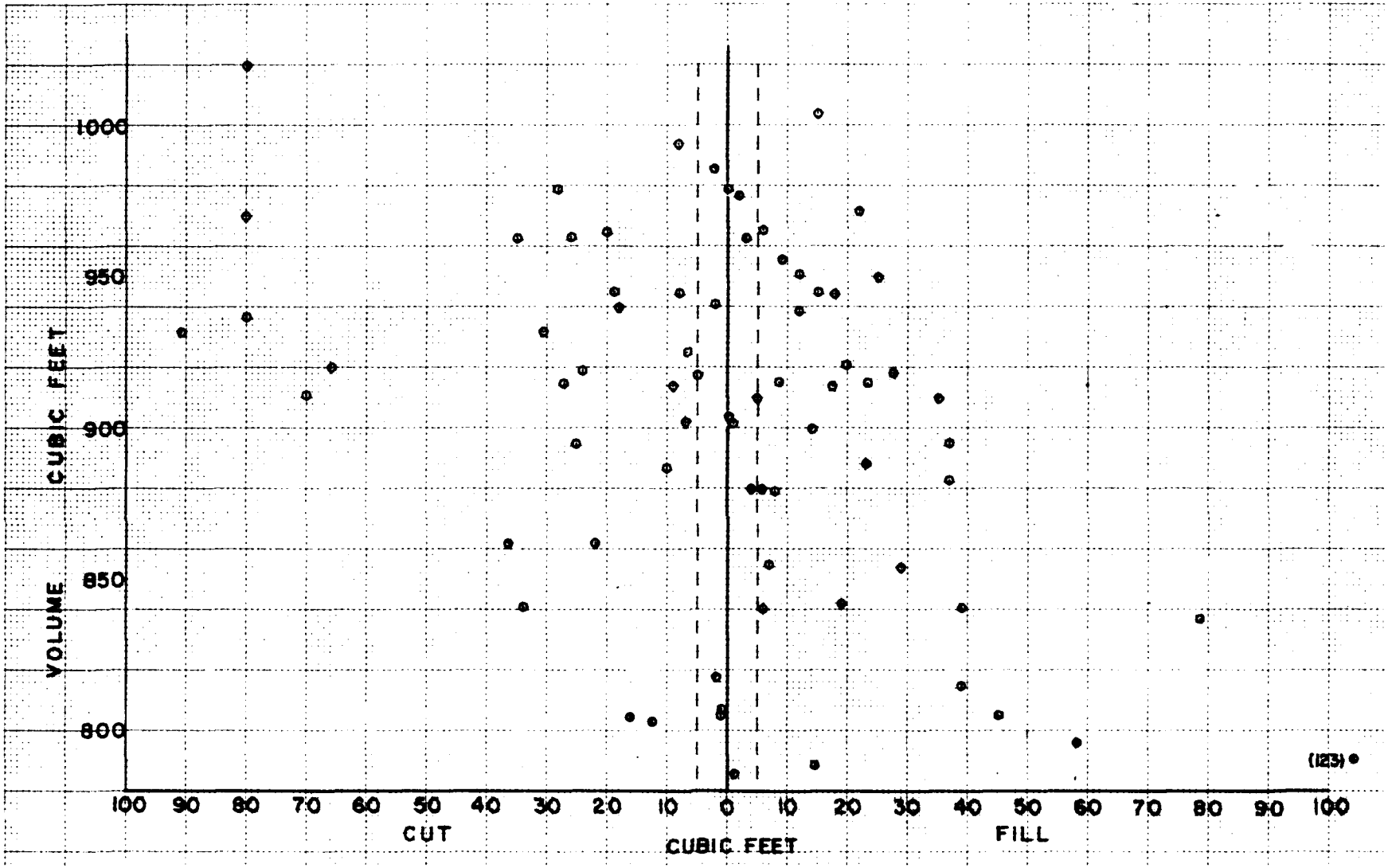
Miller, R. L. and Zeigler, J. M. (1958). A study of the relation between dynamics and sediment pattern in the region of shoaling waves, breaker zone, and foreshore. Journal of Geology, July 1958.



LOCATION CHART FOR AREA

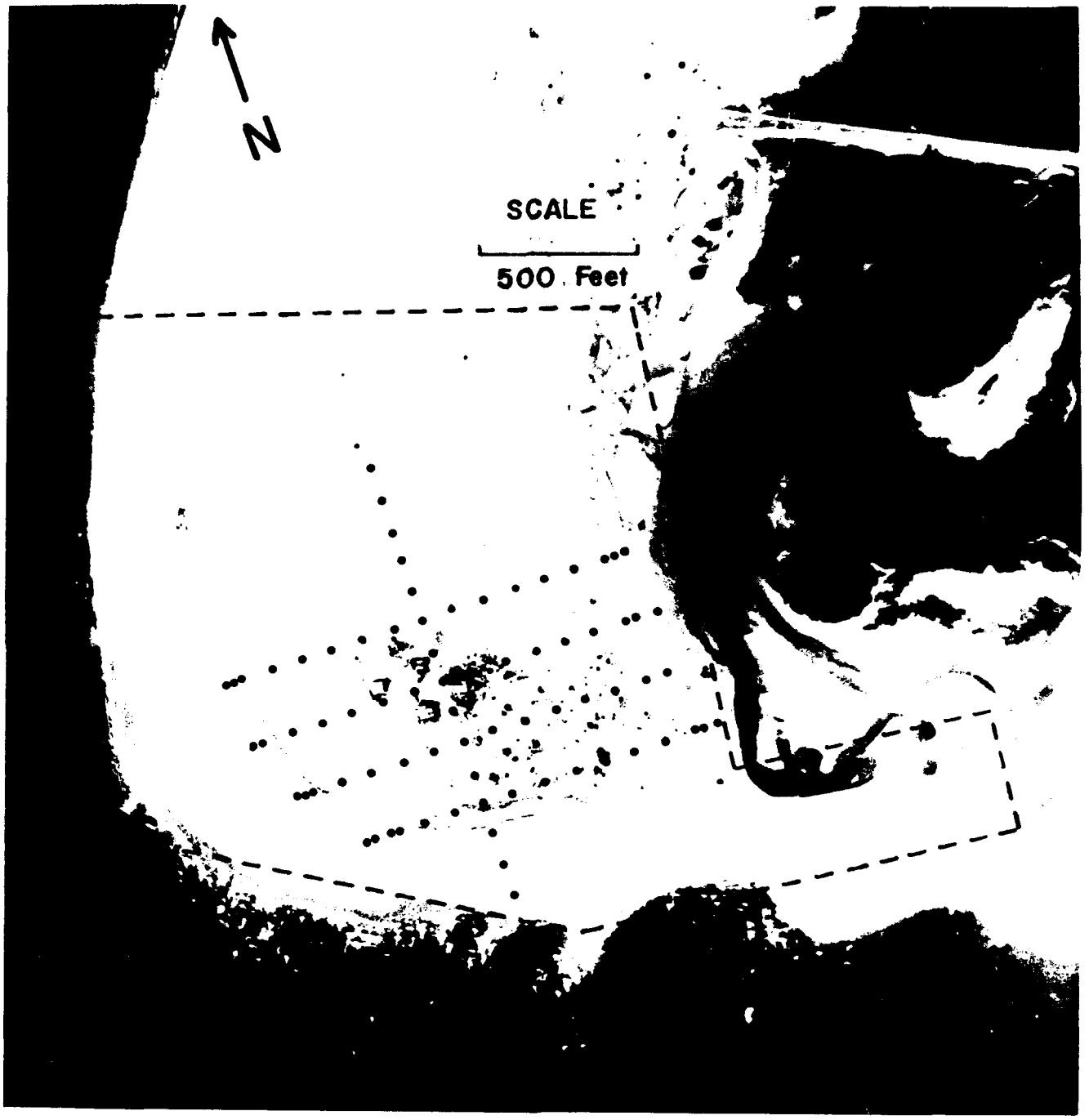
FIGURE 1



CUT AND FILL RELATED TO VOLUME

NEW BEACH - JAN. 2, 1958 TO APRIL 22, 1958

FIGURE 2



RACE POINT - APRIL, 1958
PLATE I